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The potential role of the computer in the private optometric practice

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Pacific University

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Abstract

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THESIS

The Potential Role of the Computer in the Private Optometric Practice

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A Thesis Report

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Doctor of Optometry

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by

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INTRODUCTION

The computer is a machine; there is nothing that can be said to change this. But, what many people fail to understand is the fact that it is controlled by instructions that humans produce. It will do no more or less then it is instructed to do; but will follow those instructions faithfully with speed and accuracy unmatched by human capabilities. The computer system is highly reliable, never needs to stop for lunch or coffee, and may even work 24 hours a day, if necessary.

In the profession of optometry there are many operations that are performed each day which can easily be turned over to a computer system for fast and accurate solutions without the loss of control of those operations. In addition to the many operations that are normally done there are many that are not performed because of the lack of time on the part of the doctor. This author feels that this is a poor excuse for not performing these operations because the use of them would lead to better care for the patient. As members of a health profession, we are bound, ethically at least, to provide the best care we know for the public. It is in the providing of this care that the immediate value of a computer can be realized.

But there are additional rewards from the use of a computer system that are not readily apparent. Important summaries of the total picture of optometric care can be produced as by-products of the individual operations and massive statistical patterns are also possible for future planning.

The most important quality needed in order to reap the hidden benefits of a computer system is imagination. There is virtually no end to the abilities of a computer system, but it must be controlled by humans. Humans with the imagination to convert a human problem into terms that the computer can use. This quality of imagination must be tempered by knowledge, though. The designer must know the functional characteristics and limitations of every tool he uses to produce a new item.

The information that follows has been tempered for the most part by personal experience supplemented by published literature. While few doctors will ever have the opportunity to work at a data processing center, a direct confrontation with the personnel at a center as well as the computer itself may have a great impact on gaining respect for the abilities of a computer and eliminating the mysticism that it is some kind of a "semi-human monster" that ominously gobbles up information and spits out a garbled mess of answers that are frequently distorted by errors.

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ILLUSTRATIONS

TABLES

THE OPTOMETRIC NEED

Business Operations

Virtually all of the business operations revolve around the daily flow within the office. By keeping an accurate watch on the services rendered nearly every business type of operation can be kept under control in an efficient manner. Since the needs of the optometrist would be placed under computer guidance, those needs must be defined in terms that the computer can understand. Those definitions exist as programs in the computer memory so that a minimum amount of time is needed to explain the task to the computer and provide the needed information.

The tasks that are most commonly required in the optometrist's office from the business end of the practice can all be applied to the computer for solution.

Office inventory covers the entire field of consumable items (anything from bathroom tissue to opthalmic lenses). Depending upon the size of the practice, more or less of the minor items will be controlled be computer. If the practice has a large inventory of merchandise (lenses and frames) it is absolutely necessary that accurate control of it be kept, mainly for tax purposes.

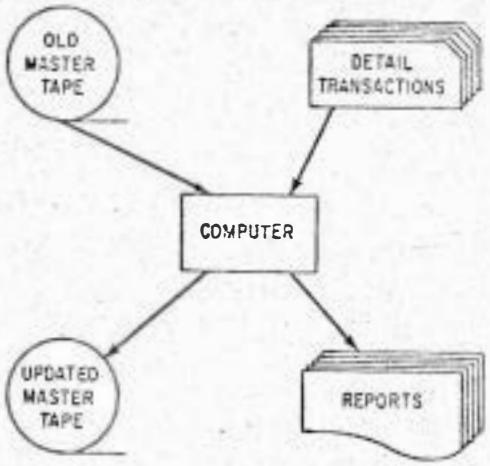


FIGURE 7-1. A Simple Batch-Controlled System

Figure 1. A Possible System for Inventory Control

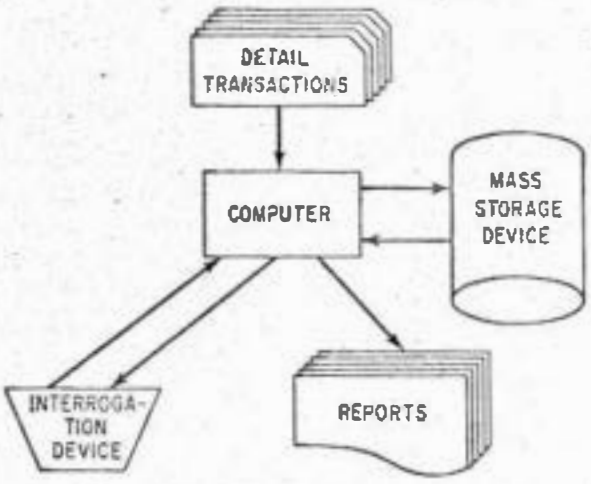


FIGURE 7-2. A Modified Batch-Controlled System

Figure 2. A Potential Plan for Billing Systems

No matter what the item, the basis for the control of inventory is to measure the amount of the item in stock, set a minimum level for re-ordering that item, keep count of the number of items used and re-order when the minimum level is reached.

Routine billing is, again, a must for the large office (or any size practice for that matter). In its simplest form the process is one of accumulating all the charges for the billing period and any payments, comparing the sum with the previous balance and arriving at the amount due. Other items that complicated the situation include insurance payments of part, or all, of the amount due, welfare, and credit plans.

Income/expense record keeping is another simplified term for the recording of every movement of money in the practice. The heart of this operation is the daily journal and the major product is the monthly summary. However, the yearly totals are also a vital part and must be worked with the assets and liabilities of the practice to yield the net gain. See figure 4 for sample plan.

Rx ordering requires the final decision on the lens powers plus all frame details and accessory lab services (such as tempering). If the practice has a high flow of patients daily, this process is repeated

many times over each day on a one-at-a-time basis.

When a patient calls for an appointment for an examination, it actually involves more than the 1-2 hours that the patient is in for that exam. Time must also be found for consultation, dispensing, progress exam and/or visual training sessions; depending upon the results of the initial exam and the needs of the patient. The utmost in accuracy must be devoted to this portion of the operation in order to prevent embarassing or professionally costly errors.

After a practive has been extablished, the volume of records from previous patient visits becomes enormous. Not only does it cost money for the space and equipment to store those records but it also costs money in the time spent extracting a particular record or part of a record for reference use.

Professional Operations

In the area of professional operations, the major difficulty seems to stem from the lack of time available to the optometrist to utilize his knowledge completely in analyzing of a set of findings. likewise, he does not have the time to look up various statistical references or compare tentative therapy programs with previously published references or correlate certain patterns with specific dysfunctions.

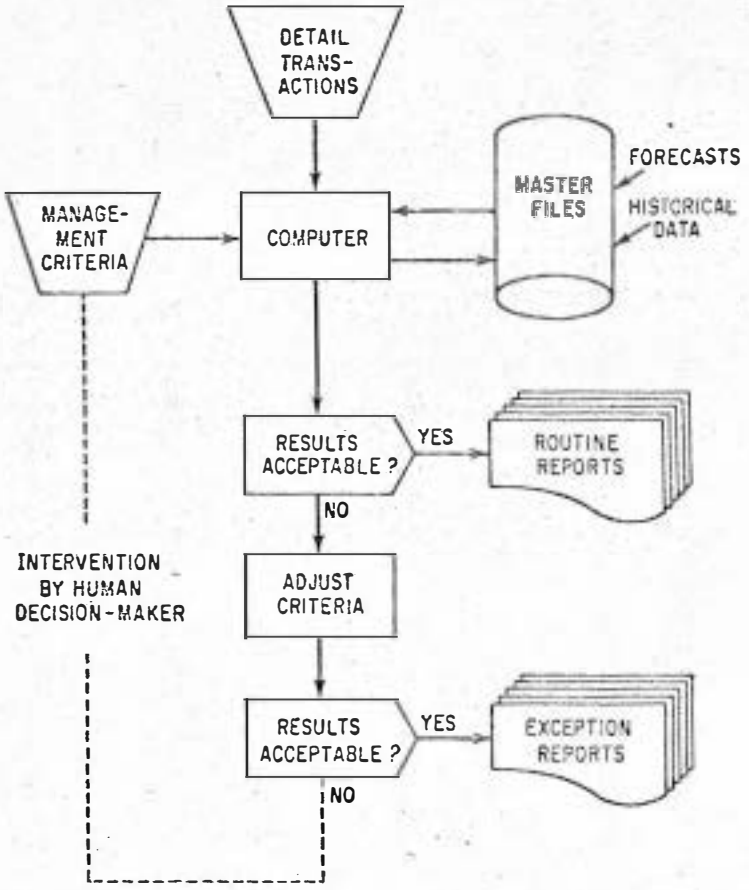


FIGURE 7–4. Schematic Diagram of a Business Information System

Figure 3. A Flow Chart With The Basic Ideas for Case Analysis

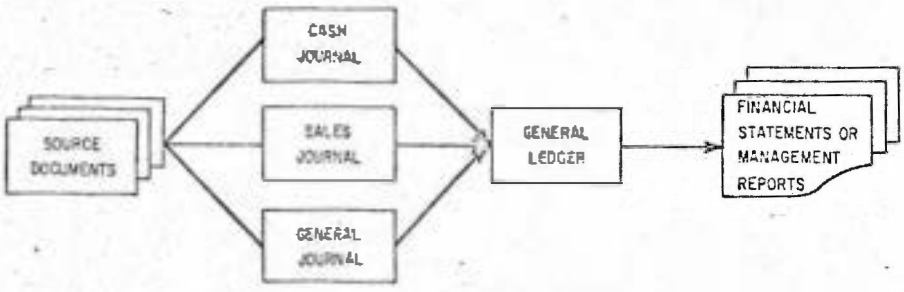


FIGURE 5–2. Diagram of a Firm's Basic Accounting Model

Figure 4. The Plan Used to Produce Varied Financial Records

To give the best service possible the doctor should use all the abilities he has in the most efficient way possible. The case findings must be analyzed individually and as a total set of findings and a pattern or syndrome determined. A statistical analysis in reference to pre-set norms or medians should also be done and correlations between certain factors made so as to determine the area of dysfunction. In the case of V. T. therapy, all the areas that are low must be analyzed in order to determine specific low portions or faulty interactions. If published group data is available it should also be used to give some idea as to the best therapy and prognosis.

THE COMPUTER RESOURCES

General Systems

The general computer system is composed of many individual devices each performing a specific task in the proper sequence such that the desired results can be obtained from the given information. This accumulation of devices can be all in one physical location or separated but connected electrically by communication lines.

Oviously there are as many different ways to combine these physical devices as there are models of them. Each combination may be set up for the best needs of the user but the system as a whole is expensive and only the "heavy user" can afford his own private system.

Out of all the individual combinations of the separate devices into working systems, the four most popular are described as follows:

Home installed - a private system with a small computer with limited abilities designed for the specific needs of the individual user. It is usually located within the physical plant of the user as a separated department. The original documents are brought to the computer, processed and the results produced at that location and then re-distributed

manually from the department to the other departments of the organization that require those results. The total flow and efficiency of the system is only as fast as the information can be transferred to and from the computer center. Greater efficiency can be had with remote terminals within the physical plant so that information is transferred directly to and from the computer center without the movement of personnel. The total number of terminals is limited as is the number of terminals that can be used simutaneously, depending upon the size of the computer. See figure 5 for illustrations of these systems.

Commercial Utility Center - is a private enterprise computer center serving the needs of many users on a "subscription" basis with a large and complex computer system (Figure 6). Transfer of information is either by mail, courier or remote terminals. The major differences between this system and the previous one manifest themselves mostly as advantages to the subscriber with only a few disadvantages. First of all the responsibilities of operating and maintaining the system lie entirely with the utility center and the subscriber is in no way responsible for such matters. Secondly, the initial investment for such services is much lower than if buying one's own computer or leasing a system for one's private use. Thirdly, for the same costs to the user, he is connected to a

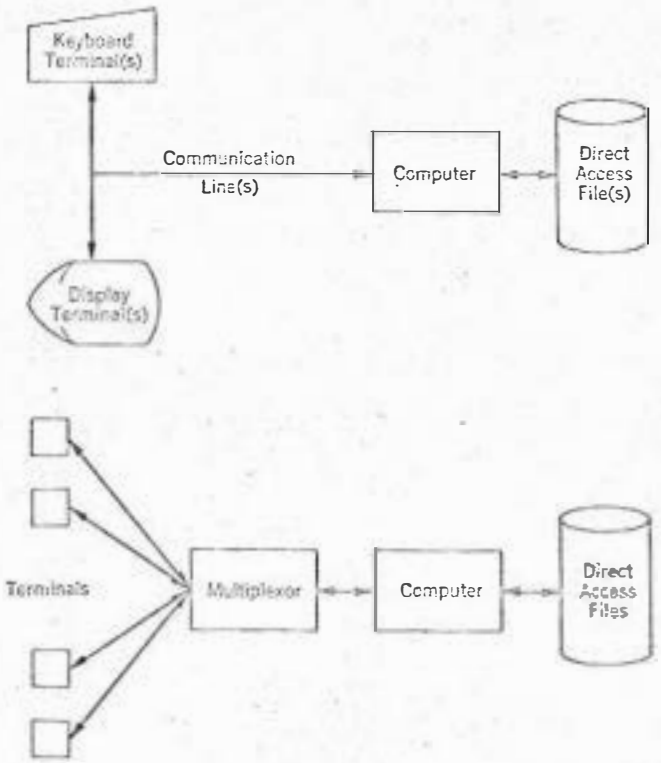


Figure 15–6. Basic real-time systems.

Figure 5. Simple and Complex Private Computer Systems

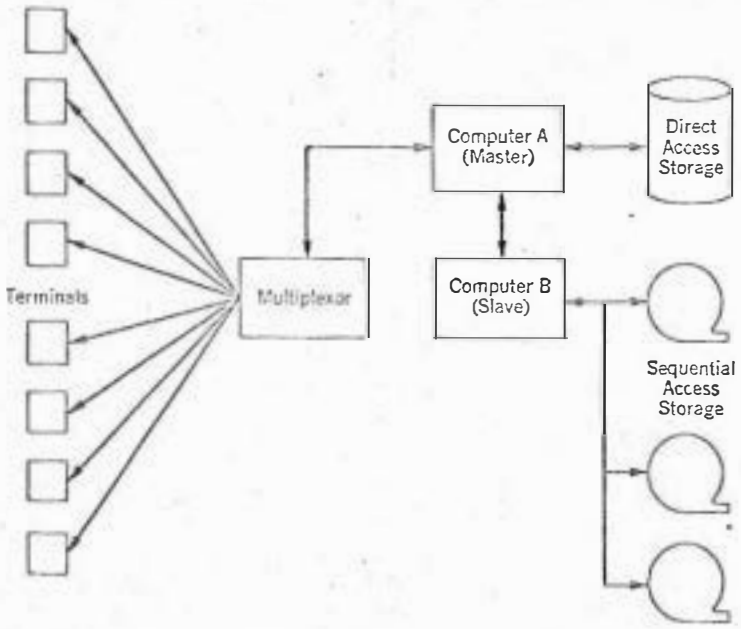


Figure 15–7. Multicomputer real-time system.

Figure 6. Sophisticated System Not Unlike a Utility Center

vastly superior computer capable of doing many more operations in less time. The primary disadvantage becomes apparent only with extremely long term usage in that the costs become greater to the user; because the self-owned computer would be paid for by then, whereas the "subscription" service fee remains constant (within the realm of inflation). Also the aspects of subscribing to a large computer service necessitate time-sharing of the computer and at peak times the accessibility to the computer may be reduced. A third and possibly minor disadvantage is that of coupling the exact needs of the user to the capabilities of the computer. While this also exists with the self-owned computer the purchaser has the choice to purchase or lease exactly what he wants for his needs. But in the case of subscribing to a computer service center, if the capabilities are not present the needs must be modified. Usually a systems analyst at the service center can work around this problem with special programming techniques, but the possibility of such a problem must be tested completely before the need arises or further complications may develope.

Large Hospital System - large hospitals may have their own computer services with extension of those services to outside professionals in the health field. It would function much the same as the commercial

utility center but be limited to the type of user and thus be specialized to the needs of the health professions.

Government System - the government (state or federal) may also be able to provide such services to special users at special cost rates, but the limitations may be greater since their primary concern in the health field is of the welfare patient and not the self-paying patient.

Specific Equipment

Computer technology has advanced a great deal in a very short time and simplified terms of the general computer field have been superseded by very specific descriptions of specialized devices coupled together to form a complete system (see figures 7 and 8).

The heart of the system is the central processing unit (CPU). It could be compared to the conducter of an orchestra. It holds all of the command instructions and controls the operations of all of the other devices in the system. It performs all of the logical and numerical operations and temporarily stores the results of those operations in a small (compared to the peripheral memory devices) but readily accessible self-contained main memory unit (see figure 9). The sophistication or complexity of this unit is described as the power of the unit and manifests itself

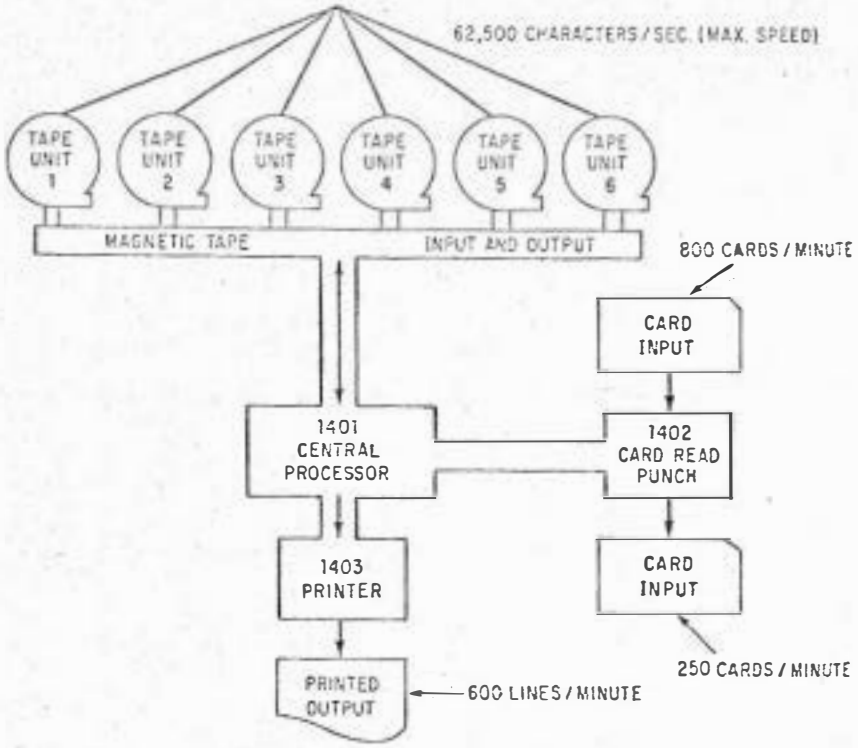


FIGURE 2–1. Schematic Diagram of the IBM 1401 Data-Processing System

Figure 7. A Complete System

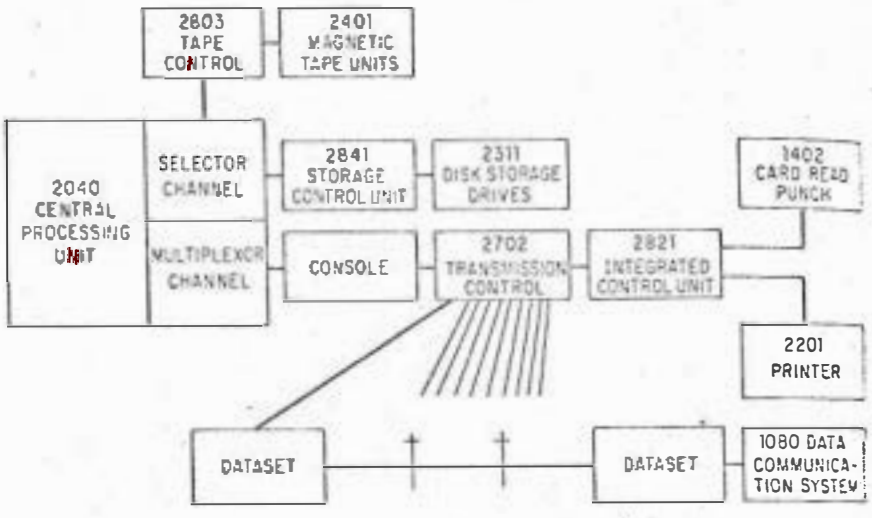


FIGURE 2–3. Schematic Diagram of an IBM System/360 with Remote Terminals

Figure 8. A Complete System, Far More Complex Than in Figure 7

EXAMPLE 1

Case Analysis

HELLO.

WHAT CAN I DO FOR YOU?
DOCTOR NO. XXX

WHO IS YOUR PATIENT?
CASE ANALYSIS

WHAT TYPE OF EXAM?
PATIENT NO. XXXX

WHAT TYPE OF ANALYSIS DO YOU WANT?
EXAM TYPE NO. X

WHAT ARE YOUR FINDINGS?
ANALYSIS TYPE NO. X

ANALYTICAL FINDINGS

ONE MOMENT PLEASE.

DOCTOR _____, YOUR PATIENT _____ HAS THE FOLLOWING RESULTS:

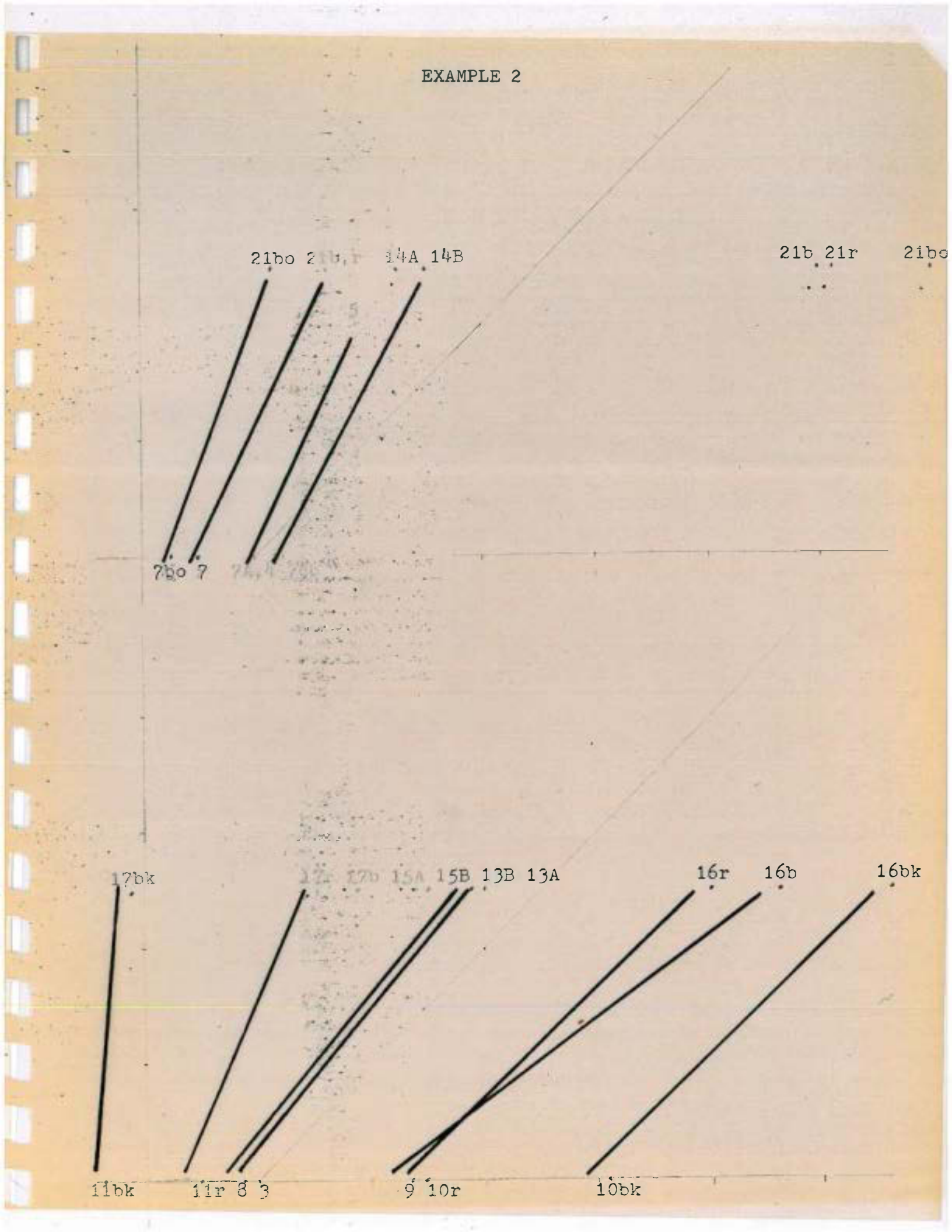
THE DIAGNOSIS IS:

THE RECOMMENDED THERAPY IS:

THE PATIENT'S NEXT APPOINTMENT CAN BE ON XX/XX/XX, AT XX:XX

GOODBYE.

EXAMPLE 2


21bo
14A
14B
21b
21r
21bo
7bo
7
17bk
16r
16b
16bk
11bk
11r
8
3
9
10r
10bk

EXAMPLE 3

Case Analysis

HELLO.

DOCTOR NO. XXX

READY.

PATIENT NO. XXX

EXAM TYPE NO. X

ANALYSIS TYPE NO. X

ENTER DATA.

ANALYTICAL FINDINGS

RESULTS:

DIAGNOSIS:

RECOMMENDED THERAPY:

EXAMPLE 4

Long Form

NUMBER 14 AGE 15. MALE NO. 7 -0.25

O.S. DOMINANT

NET NO. 2 O.D. -0.12 X180. O.S. 0.00 X 90.

NET 19 6.50 NET 20 -4.00 NET 21 2.00

NET 5 -0.75 NET 14A -1.50 NET 14B -1.00

CHAIN NO. 1 0 0 8 1011 0 1617

CHAIN NO. 2 3 0 0 0 8 9 13 15
0 0 5 0 0 0 10 0 14 16

INFORMATIVE SEQUENCE 0(0 15) 0 15 17A 20 19
7(5 0 10 16) 0 14 16A 21 0

CASE TYPE C

EQUILIBRIUM FINDINGS

	NEAR CONTROL	HABITUAL	14A NET	14B NET	EQUALIZ.
THRU	0.00	0.00	-1.50	-1.00	
	6.00	6.00	12.00	10.00	-1.25
	16.00	16.00	10.00	12.00	-1.25
	-4.00	-4.00	-2.50	-3.00	-1.00
	2.00	2.00	3.50	3.00	-1.00

HABITUAL		14A NET		14B NET	
17	20	16	21	17	2021
16	21	17	20	16	21

14A NET REJECTED
14B NET ACCEPTED

MSDA RULE NO. 8

M.S.D.A. -0.25 AND -0.25

CORRECTIVE FRAMEWORK FAR AND NEAR

NOT OVER	-0.50S	0.00C	X	0.	AND	-0.50S	0.00C	X 0.
NOT UNDER	-0.75S	0.00C	X	0.	AND	-0.75S	0.00C	X 0.
NOT OVER	-0.25S	0.00C	X	0.	AND	-0.25S	0.00C	X 0.
NOT UNDER	-0.25S	0.00C	X	0.	AND	-0.25S	0.00C	X 0.

REDUCE THE MANIFEST PLUS AT ALL POINTS

ORGANIZED	4	0	0	11	14	0	1920			
DISORGANIZED	0	9	10	0	0	16	0			

EXAMPLE 5

Short Form

NUMBER	14	AGE	15	NO. 7	-0.25
NET 5,	14A,	14B,	19,	20, AND 21 ARE	
-0.75	-1.50	-1.00	6.50	-4.00	2.00
LOW FINDINGS	10	14	16	21	0
PLUS TO EQUAL	MIN+		MAX+		MSDA
-1.25	-1.00	-1.00	0.00		-0.25
CORR. FRAMEWORK		-0.50	-0.75	-0.25	-0.25

EXAMPLE 6

J.L. McGAHN, M.D.

EARL KANTER, M.D.

WILLIAM G. WOSNACK, JR., M.D.

18 S. STENTON PL.
ATLANTIC CITY, N.J. 08401
345-2278

2 S. FRONTENAC AV.
MARGATE CITY, N.J. 08402
822-7169

634 S. SHORE RD.
SOMERS POINT, N.J. 08244
927-1104

NANCY MCCOURT
210 CHICAGO AV
EGG HARBOR NJ 08215

113

ACCT. NO. 104

MO. 3 DAY 25 YR. 70

$ AMOUNT ENCLOSED

PAYMENTS RECEIVED AFTER THE ABOVE DATE WILL APPEAR NEXT MONTH.

PLEASE RETURN THIS PORTION OF STATEMENT WITH YOUR PAYMENT.

MO.	DAY	YR.	REFERENCE	CHARGE	CREDIT
1	02	59	BAL FWD	340 00	
3	04	70	REC ON ACCT		10 00 CR

The portion of your bill which should be covered by insurance is shown in the block to the right. Please remit the difference between this and the total amount due.

2 03 30 00

TOTAL AMOUNT DUE → 330 00

EXAMPLE 7

Daily Patient Billing

```
HELLO.
     DOCTOR NO. XXX
READY.
     DAILY PATIENT BILLING
ENTER DATA.
     PATIENT NO. XXXX
     SERVICES:
     LENSES:
     FRAME:

     PATIENT NO. XXXX
     SERVICES:
     LENSES:
     FRAME:

     PATIENT NO. XXXX
     SERVICES:
     LENSES:
     FRAME:
```

EXAMPLE 8.

Accounts Receivable

HELLO.

DOCTOR NO. XXX

READY.

ACCOUNTS RECEIVABLE

A/R OVER 30 DAYS

PATIENT NO. xxxx AMOUNT xxx.xx

PATIENT NO. xxxx AMOUNT xxx.xx

TOTAL xxxxx.xx

OVER 60 DAYS

TOTAL xxxxx.xx

OVER 90 DAYS

TOTAL xxxxx.xx

FINAL TOTAL xxxxxx.xx

EXAMPLE 9

Statistical Analysis

HELLO.

DOCTOR NO. XXX

READY.

STATISTICAL ANALYSIS

CODE	DESCRIPTION	THIS MONTH	PREV.MON.	YEAR TOT.
101	Exam + Analysis	xx/xxx	xx/xxx	xxx/xxxx
102	Consultation	xx/xxx	xx/xxx	xxx/xxxx
...	.....	.. ...	.. ...	... .
...	.....	.. ...	.. ...	... .
	TOTALS	xxxx/xxxxx	xxxx/xxxxx	xxxx/xxxxx

EXAMPLE 10

STATISTICAL ANALYSIS

A BANK ANIMAL HOSP 7/20/69

PAGE ____ OF ____

90	CHECK ON ACCOUNT	77	90	559	1314	56	1464	90	10104	35
95	CASH ON ACCOUNT	3	7	48	101	14	145	60	841	02
96	DISCOUNT	4	4	25	10	60	5	20	62	15
99	CORRECTION CREDIT	1	4	24	10	00	42	00	189	40
	TOTALS	65	105	656	1436	30	1657	70	11196	92
00	EXAMINATION	16	32	175	96	00	180	00	1018	00
01	WORMING			1					5	00
09	EMERGENCY SERVICE	3	7	15	30	00	60	00	135	00
10	SMRGERY	11	14	63	235	00	298	50	1553	00
11	ANESTHESIA	5	3	14	45	00	15	00	120	00
13	DENTISTRY		1	5			25	00	110	00
14	BLD/FLUID THERAPY		2	7			12	00	39	50
15	X RAY	1	5	16	20	00	45	00	155	00
20	BOARD	17	16	134	504	00	221	50	2753	00
25	HOSPITALIZATION	2	2	16	28	00	12	00	156	00
40	INJECTIONS	10	20	71	34	00	72	00	239	50
44	DISTEMPER INJ	11	18	84	150	00	138	00	764	50
45	IMMUNIZATION	3	13	41	30	00	78	00	255	00
50	LABORATORY	1	6	15	2	00	17	00	40	00
51	URINALYSIS		2	4			4	00	8	00
52	FECAL ANALYSIS	4	2	18	18	00	4	00	52	00
60	BATH	4	8	34	17	00	61	50	208	50
65	EUTHANASIA	4	1	13	25	00	5	00	70	00
66	CREMATION	1	1	13	5	00	5	00	65	00
	TOTALS	94	153	740	1251	00	1253	50	7760	00

EXAMPLE 11

SAMPLE FORM

Case Analysis and Record Storage

Doctor No.

Patient No.

Identification Sequence

Exam Type

Analysis Type

Analytical Findings

Pathology Exam Findings

Skills — Present

Supplementary Tests for Contact Lenses — Findings

Supplementary Tests for Visual Training

Information returned by the computer:

Identification Sequence

All Present Findings

Immediate Past Findings; with asterisks nest to tests which show significant changes

Summarized History of All Findings; averaged with standard deviations for each analytical value

Second stage of computer operation:

Compute new Summarized History using present Summarized History and Present Findings

Replace Immediate Past Findings values with those of Present Findings

Store all new values back into memory for future use

EXAMPLE 12

SAMPLE FORM

Pathology Detection

Category	0	1
External		
Globe	WNL	ONL
Adnexa	"	"
Internal		
Cornea	NAP	SAP
Iris (and Ciliary Body)	"	"
Lens	"	"
Disk	WNL	ONL
Macula	"	"
Blood Vessels	"	"
Vitreous	"	"
Pupillary Reflexes	WNL	ONL
Eccentric Fixation	0	Present
Corrected Visual Acuity	20/30+	20/40-
Visual Fields		
Form Fields	NAP	SAP
Blind Spot	"	"
Color Fields	"	"
Color Vision	Norm.	Abnorm.
Tonometry	WNL	ONL

Key: WNL/ONL - within/outside of normal limits

NAP/SAP - no/signs of apparent pathology

For each category either a 0 or 1 would be used in the transmission to the computer to designate the condition observed. If the test was not made a null signal would be sent to skip over the space where the 0 or 1 should have gone. Any 1 would cause the computer to send a reminder back for an exception report.

EXAMPLE 13

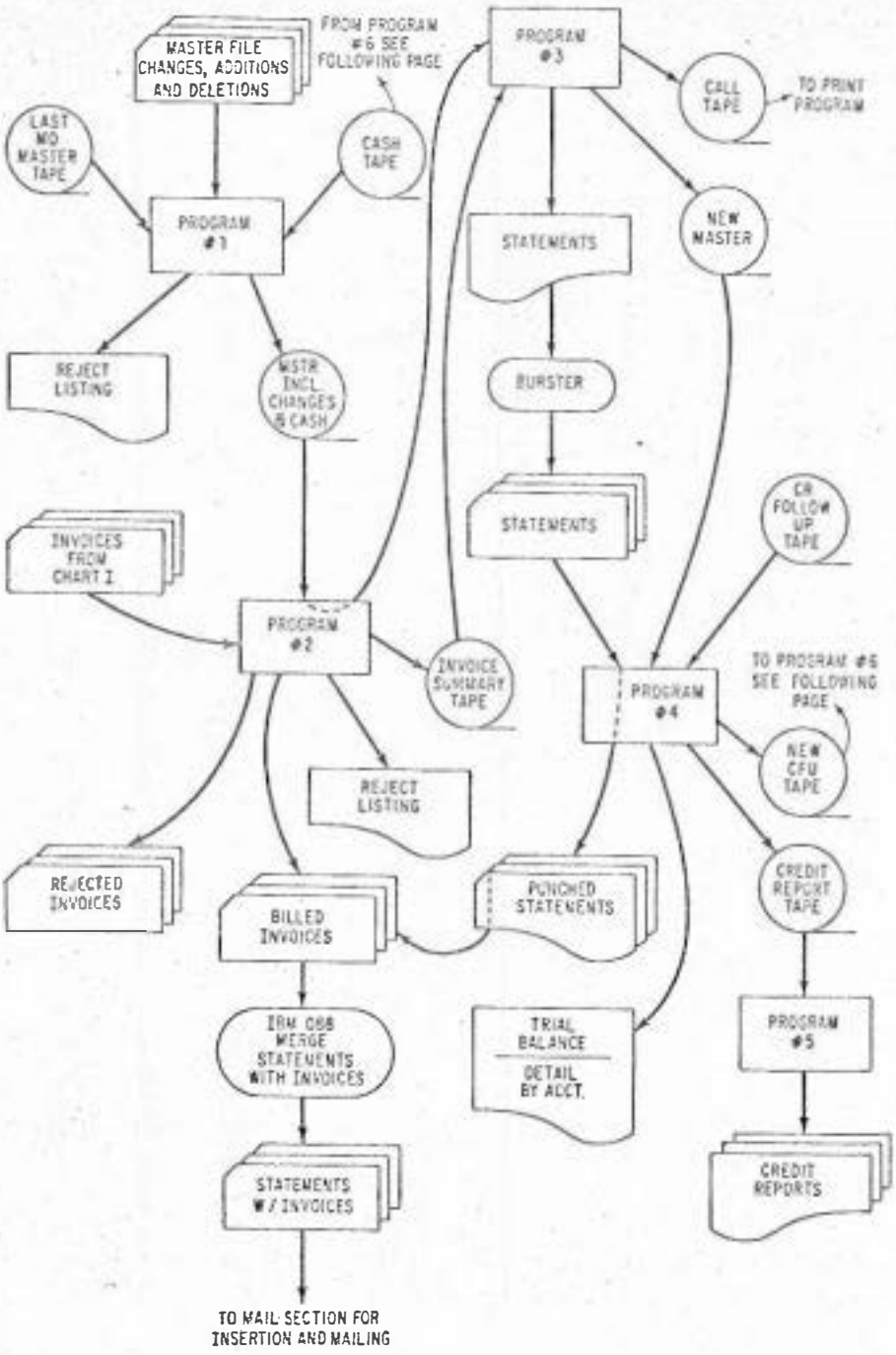


FIGURE 8–3. Computer Billing Procedures

EXAMPLE 14

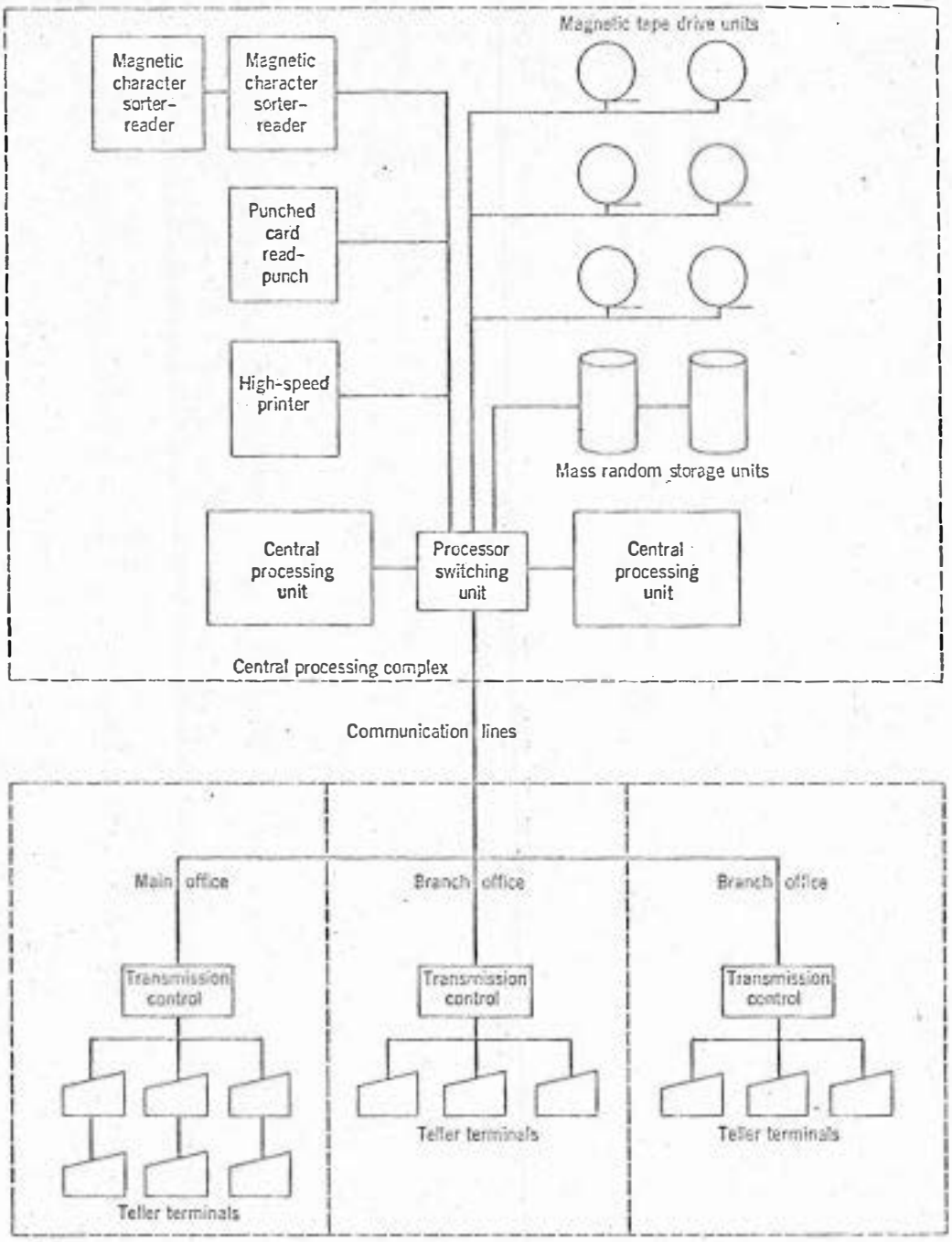


Figure 13-8. Schematic of EDP banking system.

IDENTIFICATION OF TERMINOLOGY

ACCESS TIME - the time interval between the instant at which data is called for from a storage device and the instant delivery is completed, that is, the read time; also the time interval between the instant at which data is requested to be stored and the tinstant at which storage is completed, that is, the write time.

ANALYTICAL CASE ANALYSIS - OEP standard method of case analysis.

ARITHMETIC UNIT - that part of the central processing section that does the adding, subtracting, multplying, dividing and comparing.

BATCH PROCESSING - a method of processing in which a number of similar input items are accumulated and processed together.

BUFFER - a storage device used to compensate for a difference in rate of flow of data or time of occurrence of events, when transmitting data from one device to another.

CARD PUNCH - a device or machine that punches holes in cards in specific locations to store data that can be conveyed to other machines or devices by reading or sensing the holes.

CARD READER - a device for sensing the holes in punched cards and converting that information

into data of the proper format for input to the CPU.

CENTRAL PROCESSING UNIT (CPU) - the unit of a computing system that contains the arithmetic unit, logical and control circuits necessary for the interpretation and execution of instructions.

COLLATER - a device to collate or merge cards or other documents into a sequence.

COMMAND (INSTRUCTION) - a group of signals or pulses initiating one step in the execution of a computer program.

COMPUTER UTILITY - a service which provides computational ability; a "time-shared" computer system; programs as well as data may be made available to the user; the user may have his own programs immediately available in the CPU, may have them on call at the computer utility or may load them by transmission prior to using them; certain data and programs are shared by the users of the service, other data and programs because of proprietary nature have restricted access; computer utilities are generally accessed by means of data communications subsystems.

CONSOLE OPERATOR - personnel who are on duty at the utility center to monitor and/or operate the computer.

CONTROL UNIT - the part of a computer system that effects the retrieval of instructions in proper sequence, the interpretation of each instruction and the application of the proper signals to the arithmetic unit and other parts of the system in accordance with this interpretation.

HARD COPY - a printed copy of machine output in readable form for human beings.

HARDWARE - a colloquialism applied to the mechanical, electrical and electronic features of a data processing system.

HOLDING TIME - the length of time a communication channel is in use for each transmission (includes both message time and operating time).

IN-LINE PROCESSING - that processing of data in random order without preliminary editing or sorting.

INPUT/OUTPUT (I/O) - the process of transferring information between the CPU and peripheral devices.

INQUIRY STATION - similar to remote terminal but made especially for computer control with special keys for special operations, read-out is on a carraige like that of a standard typewriter.

MEMORY - the part of a computer that stores the program, holds intermediate results and various constant data (same as storage).

OFF-LINE - pertaining to equipment or devices not under direct control of the CPU; may also be

used to describe terminal equipment which is not connected to a transmission line.

ON-LINE - the opposite of OFF-LINE.

OPERATING TIME - the time required for dialing the call, waiting for connection to be established, the coordinating of the forthcoming transaction with the personnel or equipment at the receiving end.

PERIPHERAL EQUIPMENT - equipment attached to the CPU for the handling of all data both input and output.

PROGRAM - the complete plan for the solution of a problem; more specifically, the complete sequence of machine instructions and routines necessary to solve a problem.

RANDOM ACCESS STORAGE - a storage device in which each record has a specific predetermined address which may be reached directly; access time is effectively independent of the location of data; same as direct access storage.

REAL-TIME - the processing of data derived from a particular operation in a sufficiently rapid manner so that the results of the processing are available in time to influence the continuing operation.

RESPONSE TIME - the amount of time elapsed between generation of an inquiry at the terminal and receipt of a response at the same terminal (includes transmission time to the computer, processing time at the computer and transmission time back to the terminal).

ROUTINE - a set of coded instructions arranged in a logical sequence and used to direct the computer to performa desired operation or series of operations.

SERIAL PROCESSING - the handling of data in a sequential fashion.

SOFTWARE - the programs and routines used to extend the capabilities of the computer.

SOURCE DOCUMENT - the original paper on which are recorded the details of a transaction.

STATISTICAL CASE ANALYSIS - comparison between individual case and set norms from population groups by deviation from the mean of the group data.

SUMMARY PUNCH - a card-handling machine which may be connected to another machine and which will punch out a card of information produced, calculated or summarized by other machines.

SYSTEMS SUPPORT - the managerial advice and consultation from the utility center concerning the programming and operation of the system.

TTY (TELETYPE) - the trademark of the Teletype Corp.; usually refers to a series of different types of teleprinter equipment such as transmitters, tape punches, reperforators, page printers; utilized for communication systems.

TERMINAL - an I/O device designed to receive or send source data in an environment associated with the job to be performed.

TIME-SHARING - a method of operation in which a computer facility is shared by several users for different purposes at (apparently) the same time; although the computer actually services each user in sequence, the high speed of the computer makes it appear that the users are all handled simultaneously.

TT (TOUCH-TONE) - a registered trademark of the American Telephone & Telegraph Co. which identifies its pushbutton dialing service.

VOICE GRADE CHANNEL - a channel suitable for transmission of speech, digital or analog data or fascimile generally with a frequency range of about 300 - 3000 Hz.

VOLATILE DISPLAY - the non-permanent image appearing on the screen of a visual display terminal.

FOOTNOTES

1. Hillgass, "[illegible]'s New Bid: The Century Series", Data Processing Magazine, p. 48
2. Ibid, p. 49
3. Loc. Cit.
4. Cloe, Michael, Personal Interview with author
5. [illegible]
6. Rue, Richard O., Personal Interview with the Author
7. Loc. Cit.
8. International Business Machines, Personal Interview
9. Friden Inc., Personal Interview
10. Loc. Cit.
11. Loc. Cit.
12. Cloe, Michael, Personal Interview
13. Rosenberg et. al.,"How to cash in on the Computer Utility", Data Processing Magazine, p. 40
14. Rue, Richard O., Computer Case Analysis from Biometric Data, p. 12
15. Ibid, p. 11
16. Wehrenberg, John, Whitebrook Associates, Personal Interview
17. Rue, Richard O., Computer Case Analysis from Biometric Data, p. 8
18. Ibid, p. 9
19. Haynes, Harold M., Class Lecture Notes from Opt. III

20. Rue, Richard O., Computer Case Analysis from Optometric Data, p. 8

21. Ibid, p. 9

22. Weisenbach, E. John, Whitebrook Associates, Personal Interview

23. Loc. Cit.

24. Gentle, Edgar C., Data Communications in Business, p. 176

25. Arnold, Robert R. et. al., Introduction to Data Processing, p. 260

CREDITS FOR FIGURES

1. Computer Oriented Business Systems, p. 145
2. Ibid, p. 149
3. Ibid, p. 158
4. Ibid, p. 102
5. Data Processing for Decision Making, p. 352
6. Ibid, p. 354
7. Computer Oriented Business Systems, p. 24
8. Ibid, p. 28
9. Ibid, p. 3
10. A Guide to IBM 1401 Programming, p. 23
18. Data Communications in Business, p. 128

BIBLIOGRAPHY

A Guide to IBM 1401 Programming, Daniel D. McCracken, John Whiley & Sons, Inc., 1967, New York

Computer Case Analysis from Optometric Data, Richard O. Rue and John P. Reslock, (Thesis) Pacific Univ. Library, 1970, Forest Grove, Oregon

Computer Oriented Business Systems, Wayne S. Boutell, Prentice Hall Inc., 1968, Englewood Cliffs, N. J.

Data Communications in Business, An Introduction, Edgar C. Gentle, Jr., editor, AT&T Co., 1965, New York

Data Processing for Decision Making, An Introduction to Third Generation Information Systems, Richard W. Brightman, Bernard J. Luskin, Theodore Tilton, The Macmillan Co., 1968, New York

Data Processing Magazine, "How to Cash in on the Computer Utility", Rosenberg et al; "NCR's New Bid: The Century Series", Hillgass; Vol. 10, No. 4, April 1968, Philadelphia, Pa.

Introduction to Data Processing, Robert R. Arnold, Harold C. Hill, Aylmer V. Nichols, John Whiley & Sons, Inc., 1966, New York